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Asthma essentials

Les points essentiels de l'asthme

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Abstract Asthma is a chronic, reversible obstructive disease that when in exacerbation can present to the emergency department in a spectrum of severity. Prompt recognition of the potentially severely ill asthmatic requires a careful history and physical exam while considering alternative diagnoses for the presenting symptoms. Early administration of salbutamol and corticosteroids is indicated in almost all patients with other medications such as ipratropium and magnesium and supportive modalities like BiPAP reserved for sicker patients. The global impact of asthma is increasing, especially amongst children. While the benign clinical presentation is most common and mortality has decreased in recent decades due to improved recognition and care, the ubiquity of the condition and frequent lack of regular outpatient management contribute to the disease claiming 250,000 lives worldwide annually. The emergency physician must be prepared to assess and appropriately manage both the young child with a mild wheeze and the adult in respiratory failure.

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Abstract L'asthme est une maladie chronique et réversible qui, en cas d'aggravation, peut faire l'objet de visites au service des urgences à différents degrés de gravité. L'identification rapide de l'asthmatique potentiellement très malade nécessite un examen soigné des antécédents médicaux et physiques et la prise en considération de diagnostics alternatifs quant aux symptômes présentés. L'administration précoce de salbutamol et de corticostéroïdes est indiquée pour la quasi-totalité des patients sous traitement différent, comme l'ipratropium et le magnésium, et utilisant des modalités de traitements comme le BiPAP pour les patients plus gravement malades. L'impact global de l'asthme augmente, notamment chez les enfants. Si la maladie se présente le plus souvent sous forme bénigne et si la mortalité a diminué au cours de ces dernières décennies grâce à une meilleure identification et une meilleure prise en charge, l'ubiquité de cette maladie et l'absence fréquente de prise en charge régulière des patients externes contribue au décès attribuable à la maladie de 250 000 personnes par an dans le monde. Le médecin d'urgence doit être préparé à évaluer et gérer comme il se doit le jeune enfant présentant un léger sifflement comme l'adulte en détresse respiratoire.

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Introduction

Asthma is a chronic reversible inflammatory condition affecting the lower airways, most prevalent amongst children and adolescents. Clinical presentation can range from mild wheezing, cough, or chest tightness to severe respiratory distress or respiratory failure. Prompt recognition and administration of medications are critical for effective management.

Epidemiology

Asthma affects approximately 300 million people worldwide.¹ While typically thought of as a disease of urban centres in North America and Europe, asthma has a significant and growing impact on health throughout Africa. Although available data to evaluate trends in Africa are limited², a recently published review of the available literature suggests that prevalence is rising throughout sub-Saharan Africa, with rates from 5.7% to 20.3%, and highest in urban areas.³ While lack of standardized reporting in most of the rest of Africa prevents proper comparison, South Africa's mortality rate of 18.5/100,000 asthmatics ranks fifth-highest in the world.¹ As more Africans adopt western lifestyles and move to urban centres, the current estimate of close to 50 million asthmatics living on the continent is expected to grow.¹

Pathophysiology

Asthma is a chronic, reversible obstructive disease of the lower airways. Constriction of bronchial smooth muscle in acute attacks leads to the characteristic wheezing associated with asthma. In addition to bronchospasm, inflammation causing microvascular leakage and airway oedema leads to further airway narrowing.

The pathophysiologic changes in an asthma exacerbation involve multiple inflammatory cells and mediators. Allergens activate mast cells through an IgE-mediated pathway, caus-

ing release of bronchoconstrictor mediators.⁴ Similar release occurs in a non-IgE-mediated pathway secondary to cold exposure, exercise⁵, and medications such as NSAIDs or aspirin.⁶ The release of specific chemokines and cytokines from inflammatory cells promotes further local inflammatory change.^{7,8}

Initial evaluation

Formal diagnosis of asthma is based upon pulmonary function testing, but the diagnosis is made on clinical grounds in the acute setting. Episodic wheezing, shortness of breath, chest tightness, and cough are clinical hallmarks although any combination of these symptoms is possible. The history should include when the current symptoms started, how they compare to previous exacerbations, and response to any medications administered prior to presentation. It is also important to ascertain the dosage of all current medications, previous hospitalizations or intubations for asthma, and the presence of other cardiac or respiratory disease.

Patients should be placed in an area where monitoring and frequent re-evaluations can be performed by a staff. Continuous pulse oximetry is indicated in patients that are hypoxic on arrival or are in severe distress.⁹ While initial vital signs and ensuing changes can be a useful marker of clinical status, normal or near normal vital signs do not exclude the diagnosis of severe asthma exacerbation.

History

Identifying the potentially seriously ill asthmatic is often difficult, as physical exam findings indicative of severe airflow obstruction such as use of accessory muscles, diaphoresis, and inability to lie supine due to breathlessness are not sufficiently sensitive.¹⁰ This increases the importance of obtaining a good history of present illness and thorough past medical history. Frequency of usage and compliance with home asthma medications, more than three visits to the emergency centre in the past year, admission to the hospital floor or

ICU in the past month, and previous intubations are indicators of a patient that could be at risk for acute decompensation and respiratory failure.^{11,12} Such consensus guidelines regarding risk factors have borne out in studies at African hospitals.¹³

Physical exam

The physical exam hallmarks in acute asthma exacerbation are classically wheezing, tachypnoea, respiratory distress, cough, chest tightness, and accessory muscle use, which can be present in any combination.¹⁴ Monitoring level of consciousness, respiratory rate, accessory muscle use, and degree of wheezing are elements of the exam repeated to assess a patient's clinical status in response to therapeutics.

Testing

While some recommend the use of ABG as a measurement of respiratory status (specifically evaluating for hypercarbia in the severely ill patient potentially failing treatment), common practice is to make decisions regarding treatment based on clinical grounds. Peak expiratory flow (PEF) is a quantitative measure of lung function that when included in a patient's assessment is more reliable in assessing severity than clinical symptoms alone.¹⁵ When obtained at presentation, PEF provides an objective baseline of airway obstruction to compare against following therapeutic intervention. Most improvement in PEF will be after the first treatment with beta agonists.¹⁶

Other blood testing and imaging including chest X-ray are generally only warranted when alternate diagnoses such as pneumonia or foreign body are being considered and should not be part of routine evaluation.¹⁷

Assessment

Differentiating mild, moderate, and severe asthma exacerbations is done on clinical grounds and, if available, peak expiratory flow (PEF). Mild asthma is characterized by moderate expiratory wheeze, PEF <80% predicted or personal best, dyspnoea with exertion, and ability to speak in full sentences. In moderate asthma exacerbations (PEF 60–80%) the patient has dyspnoea with talking, a loud wheeze and possibly supra-sternal retractions and accessory muscle use noted on physical exam. The severe asthma (PEF <60%) patient will commonly be unable to speak more than words secondary to dyspnoea, exhibit accessory muscle use, and have marked inspiratory and expiratory wheezes on auscultation.¹⁸ Very poor air movement with or without wheezing (often referred to as a “silent chest”), respiratory muscle fatigue, cyanosis, and altered mental status are findings concerning for impending respiratory arrest.¹⁹ Identifying where a patient falls within this spectrum can be helpful when considering therapeutic options and likely disposition.

When evaluating paediatric patients there is increasing reliance on the physical exam, as obtaining PEF values in infants and children under five years of age (and frequently in older children) is nearly impossible. In addition to clinical judgment, pulse oximetry at presentation and after one hour of treatment in this population can be a useful adjunct to help assess clinical status.²⁰

Differential diagnosis

Following the dictum “All that wheezes is not asthma,” a common mistake is to not consider other diagnoses in the wheezing patient. Especially in the paediatric population, upper respiratory tract infections can cause lower airway inflammation and clinical wheezing. Neither airflow limitation nor airway inflammation can be routinely assessed in children under the age of 5, adding to the difficulty of diagnosis in this age group and increasing the importance of a thorough history.²¹ While in adults many patients will carry a known diagnosis of asthma, in the wheezing paediatric patient further information regarding the frequency of similar symptoms, any known triggers (such as cockroaches, mites²², mould, pollen, air pollution, animal dander, and tobacco smoke²³), family history, and previous response to bronchodilators can help differentiate asthma from wheezing associated with viral illness or other disease processes.¹⁴

Other disease processes to consider in the wheezing patient are COPD, congestive heart failure, pulmonary embolism, pneumonia, tumours, cough secondary to drugs (ACE inhibitors, etc.), foreign body aspiration, aspiration pneumonitis, allergic rhinitis, postnasal drip, gastroesophageal reflux, and vocal cord dysfunction.¹⁹ The clinical features of COPD and asthma closely overlap; in the older patient with a reported history of asthma presenting with acute shortness of breath suspected to be of pulmonary origin a heavy smoking history and initial onset of symptoms in middle age could suggest COPD as the underlying aetiology. Even with outpatient pulmonary function testing the diagnosis often remains unclear, also many patients have both diseases.²⁴

Management

Oxygen

Asthmatic patients can develop hypoxaemia secondary to ventilation-perfusion mismatch. Any patient with an initial oxygen saturation of less than 90% should receive supplemental oxygen, first via nasal cannula, reserving non-rebreather masks for those who remain hypoxaemic on nasal cannula. Flow should be titrated down to the lowest level required to maintain the oxygen level above 90%. A target of 95% is recommended in children, pregnant women, and those with coexistent heart disease.¹⁸

Bronchodilators

Effective treatment of the acute asthmatic exacerbation is predicated on rapid administration of bronchodilators to all patients. Short-acting beta agonists relieve bronchospasm and can be given in different forms, via intermittent or continuous nebulization or metered dose inhalers (MDI) with a mask or mouthpiece. Depending on resources, all are reasonable treatment options in mild to moderate exacerbations and have been shown to be equivalent in both paediatric and adult populations.²⁵ MDIs are favourable in regard to cost and shorter duration of stay in the emergency centre.²⁶ Homemade spacers made of soda bottles can be as clinically effective as commercial spacers, both helping increase the amount of medication inhaled.²⁷

Salbutamol is the most common beta-2 agonist used for acute asthma. Dosing of this medication via MDI (90 mcg/puff) with a spacer device is 4–8 inhalations every 20 min for up to 4 h. In paediatric patients 4–8 inhalations every 20 min for three doses, then every 1–4 h. For continuous nebulization, 2.5–5.0 mg of salbutamol (or 0.15 mg/kg in paediatric patients) is administered every 20 min for 1 h.²⁸ Side effects of salbutamol include tachycardia, tremor, hypokalaemia, palpitations, and hyperglycaemia.

Anticholinergics

Ipratropium has been shown to be an effective adjunct to inhaled beta agonists in moderate to severe asthma exacerbations. A muscarinic acetylcholine receptor inhibitor, ipratropium works to relax vagally-mediated smooth muscle. Due to its slow onset time (90 min) and lesser potency as a bronchodilator, ipratropium should never be used as a single agent for acute asthma. via nebulizer 0.5 mg of ipratropium is given every 20 min for a maximum of three doses. When administering with a MDI, 8 puffs every 20 min for upwards of 3 h is a standard regimen. While recommended in all age groups, it has been found to be especially effective in paediatric populations, helping to decrease hospital admissions by 25% in children.¹⁴ There is no evidence-based role for ipratropium in mild exacerbations, and if unavailable, most patients can be safely managed with salbutamol alone in the outpatient, emergency centre, and inpatient settings.

Steroids

The early administration of corticosteroids is recommended in patients with moderate to severe exacerbations or those patients not responding quickly or completely to beta2-agonist therapy. Corticosteroids work to decrease the inflammatory reaction that with bronchospasm characterize acute asthma. Prednisone is most commonly given; clinical effect is typically within six hours. Early administration of corticosteroids has been shown to decrease hospital admission and relapse rates.^{29,30} Oral corticosteroids should be continued for 3–10 days (Prednisone 40–60 mg is typical) following discharge

to decrease the risk of relapse. Depending on availability, prednisolone (1–2 mg/kg for 3–5 days) and hydrocortisone (2–4 mg/kg) are also appropriate alternatives. Oral and intravenous steroids are equivalent although the intravenous route is recommended for patients in respiratory failure and others unable to tolerate medication by mouth.³¹ Typical dosage for the critically ill asthmatic is intravenous methylprednisolone 60–80 mg every 12 h.

Magnesium

Intravenous magnesium causes bronchodilation by inhibiting the influx of calcium into cells. This medication is generally reserved for severe exacerbations and has been shown to decrease the rate of hospital admission.³² The standard dose is 2 mg intravenous infused over 20 min.

Methylxanthines

Intravenous aminophylline and theophylline as individual agents are inferior to beta agonists and provide no significant further bronchodilation when given in addition to beta agonists to adult patients and non-critically-ill children.³³ Thus their administration is not recommended as part of standard treatment for acute asthma exacerbation. In addition to other standard treatment, intravenous bronchodilators can be considered in paediatric status asthmaticus patients with impending respiratory failure, being mindful of their significant side effect profile.³⁴

Epinephrine

While in theory it may decrease airway resistance and oedema, there is insufficient evidence to support the routine use of epinephrine in the management of the critically-ill asthma patient.³⁵ One scenario in which the subcutaneous administration of epinephrine is recommended is in the prehospital setting when salbutamol or another short-acting beta2-agonist is unavailable.¹⁴

Heliox

The rationale behind the administration of helium–oxygen mixtures (80:20 or 70:30) in asthmatics is that the low density of helium decreases turbulent airflow, thus allowing for improved ventilation and decreased work of breathing. This property of helium is also thought to help maximize delivery of salbutamol to the lung periphery, thereby enhancing bronchodilation. Available clinical data regarding efficacy of Heliox are mixed due to lack of large trials; at this time it cannot be recommended as a part of the standard management of the asthmatic patient.³⁶ Heliox-driven nebulization of salbutamol should be considered for severely-ill patients that do not respond to conventional therapies within one hour.³⁷ Standard

administration is with the gas mixture set at 8–10 L/min and double the usual dose of salbutamol.

BiPAP

Commonly used in the management of congestive heart failure and COPD, non-invasive positive pressure ventilation has been increasingly utilized in severe asthmatics not improving with standard therapy. Small trials have shown decreased rates of hospitalization in adults and also possible benefit amongst paediatric patients.^{14,38} A higher quality study is required before non-invasive positive-pressure ventilation (NPPV) becomes part of standard recommended practice for severe asthmatics but can be considered when the next step in management for the patient failing medical therapy is intubation.

Intubation and mechanical ventilation

The severely ill asthma patient that requires intubation is rare, but this level of airway management may be required when other measures fail. Indications include worsening mental status, respiratory arrest, or severe hypoxaemia. Ketamine is the preferred induction agent for rapid sequence intubation for its bronchodilatory properties.³⁹ Intubation should be a last resort in the asthmatic, as they are often difficult to appropriately manage on the ventilator. The risk of barotrauma secondary to auto-PEEP and hyperinflation can be minimized by reducing respiratory rate and tidal volume and increasing exhalation time by increasing inspiratory flow rate. It is critically important to decrease the I:E ratio substantially (3–5 times normal) in intubated asthma patients to ventilate them safely.

Disposition

While the decision is clear in the severely ill asthmatic patient that requires ICU or other higher level monitoring, for the moderate exacerbation determining disposition can be difficult and depends largely on clinical judgment. Factors that suggest the need for admission include PEF <40% of predicted following treatment, new-onset asthma, multiple previous hospitalizations for asthma, use of glucocorticoids at time of presentation with worsening of symptoms, and complicating psychosocial factors.

Patients demonstrating rapid improvement following treatment should be observed for at least 30–60 min prior to discharge to monitor for relapse.⁴⁰ If the decision is made to discharge a patient, oral glucocorticoids for 3–10 days have been shown to decrease relapse rate and are generally indicated in those patients with a severity of illness that necessitated an emergency centre visit.²⁰

Summary

Prompt recognition of the clinical symptoms of asthma and timely administration of beta-2 agonists and corticosteroids,

while under close monitoring considering the need for ipratropium and magnesium are integral to managing the sick asthmatic patient.

African relevance

- Asthma is recognized as having an increasing impact on the health of Africans, especially in urban areas.
- Early diagnosis and proper management can significantly improve morbidity and mortality while requiring little to no testing.
- Widely available and currently utilized therapeutics can be augmented by newer treatment modalities in the care of the critically ill asthmatic.

What's new?

- Prompt recognition via history and physical exam of the severely ill asthmatic patient and timely therapeutic intervention can decrease hospital admission.
- Salbutamol and corticosteroids are the mainstays of treating acute asthma; magnesium and ipratropium should be reserved for the moderate to severe exacerbation.
- Emerging therapies including Heliox and BiPAP are potentially useful adjuncts in staving off intubation in the most critically ill asthma patients.

Appendix A. Short answer questions

Test your understanding of the contents of this original paper (answers can be found at the end of the regular features section).

1. A 30-year-old man with a history of asthma presents to the emergency centre with worsening shortness of breath refractory to his prescribed salbutamol inhaler. Initial vital signs include a respiratory rate of 14 and SaO₂ of 99%. On physical exam he is in minimal distress with bilateral expiratory wheezes on auscultation. Your initial management is to order:
 - a. an arterial blood gas analysis
 - b. a chest X-ray
 - c. salbutamol via nebulization or metered dose inhaler
 - d. oxygen via nasal cannula
 - e. BiPap
2. Which medication has been shown to have benefit in moderate and severe asthma but not in the mild exacerbation?
 - a. Theophylline
 - b. Magnesium
 - c. Salbutamol
 - d. Montelukast
 - e. Azithromycin

3. The preferred induction agent when intubating the severely ill asthma patient is:

- a. Midazolam
- b. Etomidate
- c. Thiopental
- d. Ketamine
- e. Lorazepam

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